



Rewarding Learning

**ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023**

Environmental Technology

Assessment Unit AS 1

assessing

**The Earth's Capacity to Support
Human Activity**

[SET11]

THURSDAY 25 MAY, AFTERNOON

**MARK
SCHEME**

General Marking Instructions

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

Quality of candidates' responses

In marking the examination papers, examiners will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

Flexibility in marking

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of 17- and 18-year-old candidates. Conversely marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

Types of mark schemes

Mark schemes for questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper. Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form.

- 1 (a) Any **three** of the following:
plastics, pharmaceuticals, transport, fibres [3]

All relevant, valid responses will be given credit.

- (b) (i) Any **two** of the following:
- Countries are assigned maximum carbon emission levels in the form of carbon permits. [1] If a country exceeds its maximum level it must buy extra carbon permits from other countries. This financial penalty encourages the country to lower their CO₂ emissions. [1]
 - Countries who produce less than their allotted carbon emissions can sell their carbon permits to other countries. [1] This financial incentive encourages the country to lower their CO₂ emissions. [1]
 - Countries are assigned carbon permits each year. Countries who fail to lower their CO₂ emissions will be penalised by getting a lower number of carbon credits in the next year. [1] Therefore encouraging the country to lower their CO₂ emissions. [1] [4]
- Award [2] for a detailed discussion and [1] for a limited discussion.

All relevant, valid responses will be given credit.

- (ii) Any **three** of the following:
- The market is open to fraud. Larger countries can manipulate smaller countries and force them to sell their credits at a low price. [1]
 - Businesses may not participate. Some businesses can afford to pay the fines without even trying to reduce their carbon dioxide output. [1]
 - Credit limits may be too high. Setting the credit limits is extremely complicated and can lead to some participants being given too many credits, giving them no incentive to lower their carbon dioxide emissions. [1]
 - It is difficult to measure emissions accurately and consistently across so many different countries and industries. [1] [3]

All relevant, valid responses will be given credit.

- 2 (a) Reduce emissions of greenhouse gases by 20% by 2020 taking 1990 emissions as the reference. [1]
Increase energy efficiency to save 20% of energy consumption by 2020. [1]
To reach 20% of renewable energy in the total energy consumption by 2020. [1] [3]

- (b) Some governments are now more aware of their responsibilities with regard to their current use of fossil fuels. [1]

All relevant, valid responses will be given credit.

- (c) Any **one** from the following:
- Renewable energy sources need to be used [1] for example renewable technologies such as wind farms and solar farms as these technologies can produce energy without using fossil fuels. [1]
 - Investment in nuclear power plants [1] to replace fossil fuel power stations, therefore reducing the need for fossil fuels. [1] [2]
- Award [2] for a detailed discussion and [1] for a limited discussion.

All relevant, valid responses will be given credit.

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- 3 (a) (i) Any **two** of the following:
Wind, Hydroelectricity, Wave, Tidal [2]

All relevant, valid responses will be given credit.

- (ii) An indirect renewable source of energy will take energy from a renewable source [1] such as the sun and using a physical characteristic of the material being used, convert this energy into electrical energy. [1] [2]

Award [2] for a detailed explanation and [1] for a limited explanation.

All relevant, valid responses will be given credit.

- (b) (i) Any **three** of the following:
- Reduces reliance on fossil fuels. [1] Using a ground source heat pump will provide heating for the house, therefore replacing the need to use fossil fuels for heating. [1]
 - Reduces heating bill. [1] The heat from the sun replaces the need to purchase heating fuel. [1]
 - Makes a contribution towards environmental targets. [1] Less fossil fuels are being burned to produce heat, therefore less carbon dioxide emission and GHG's. [1]
 - Enhanced security of supply. [1] Not dependent on fluctuating prices of fossil fuels. [1] [6]

Award [2] for a full discussion and [1] for a partial discussion.

All relevant, valid responses will be given credit.

- (ii) Coefficient of performance = $\frac{\text{Energy output from heat pump}}{\text{Energy used by heat pump}}$ [1]

Coefficient of performance = $\frac{24}{4.8} = 5$ [3]

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- 4 (a) Existing mass (9 tonnes) is proportional to cube of blade length [1]
If we double blade length to 2r then
New mass is proportional to $(2r)^3$ which is $8r^3$ [1]
New mass = existing mass (9 tonnes) $\times 8$ (or 2^3) = 72 tonnes [1]

All relevant, valid responses will be given credit [3]

- (b) (i) Kinetic energy = $\frac{1}{2} mv^2$ [1]
 $43000 = 0.5 \times 860 \times v^2$
 $43000 \div (0.5 \times 860) = v^2$ [1]
 $100 = v^2$
 $10\text{m/s} = v$ [1] [3]

- (ii) 43000×0.593 [1]
 $= 25499\text{J}$ [1] [2]

- (c) Blade length:
Longer turbine blades have a greater swept area so can harness more wind power, increasing turbine performance. [1] They may require higher cut-in wind speeds unless they are composed of lightweight/composite materials. [1]

Strength of materials:

Strong materials are required to withstand the forces acting on the turbine blades. [1] Stronger blades may be heavier and may need higher cut-in speeds to generate power which will reduce the efficiency/performance of the turbine. [1]

[4]

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Award [2] for a detailed explanation and [1] for a limited explanation.

All relevant, valid responses will be given credit.

5 (a) Flat plate solar collector [1]

(b) Any three comparisons from:

- Both solar collectors transfer solar energy to water in a storage tank [1] via a pipe network containing a fluid, often water. [1]
- In a flat plate collector, the absorber plate is in direct contact with the pipe network. [1] In an evacuated tube collector, the absorber plate is contained in a vacuum tube and is not in direct contact with the pipe network. [1]
- In a flat plate collector, the absorber plate absorbs solar energy as heat, which is transferred to the pipe network. [1] In an evacuated tube collector, a thermal fluid is heated by the absorber plate and evaporates inside the vacuum tube. Its heat energy is transferred to the pipe network via a heat exchanger. [1]
- Evacuated tube solar collectors are more efficient than flat plate solar collectors. [1] A smaller area of evacuated tube solar collectors is required to deliver the same heat energy as flat plate solar collectors. [1]

[6]

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Award [2] for a detailed comparison and [1] for a limited comparison.

All relevant, valid responses will be given credit.

6 (a) (i) Compressed air energy storage/CAES [1]

(ii) Compressor [1]

(iii) Compressed air [1]

(iv) At times of low demand (off-peak), electrical energy from a renewable energy source [1] compresses air for storage in an underground store/cavern [1].

At times of high demand, air is released to the surface [1] and heated using gas to expand its volume. It is then used to drive a turbine to generate electricity. [1]

[4]

All relevant, valid responses will be given credit.

(b) Any two features from:

1. Availability of existing water facilities (lakes/reservoirs) [1] to avoid the need for excavation with associated costs and environmental impact. [1]
2. A suitable head height [1] so that there is sufficient potential energy stored in the upper facility to drive a turbine and generate electricity. [1]
3. Proximity to transmission lines. The facility needs to connect to the grid as cheaply as possible. [1] Installing new transmission networks causes environmental and social issues as well as adding to cost. [1] [4]

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Award [2] for a detailed discussion and [1] for a limited discussion.

All relevant, valid responses will be given credit.

7 Indicative Content

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The current issues surrounding the global production and use of plastics

- Global production of plastic continues to increase each year.
- Plastic production is the largest single user of crude oil outside the energy and transport sectors.
- Polymers and plastics made from crude oil derivatives cannot be broken down by micro-organisms or easily recycled.
- Toxic gases are released by incinerating plastic materials.

The manufacture of and uses for degradable plastics

- Incorporating additives into the polymer during the manufacturing process to enhance biodegradability.
- Modifying the manufacturing process to enhance thermal and photo degradation.
- Producing compostable plastics that can improve soil composition in regions where soil structure is poor.
- Use for agricultural films, packaging and labelling.

Experimental methods used to compare the degradability and tensile strength of polythene and photodegradable plastic.

- Degradability is compared using a propagator with ultraviolet (UV) bulbs.
- Samples of plastics of equal size are used.
- UV light is shone on the samples for a fixed time and the progress of the plastics is monitored at intervals by e.g. taking photos.
- Tensile strength is compared using a Newton meter.
- Tensile strength is the ability (of a plastic) to withstand force applied to it. [15]

All relevant, valid responses will be given credit.

Response	Mark
Level 3 The candidate demonstrates a very good understanding of the current issues surrounding the global production and use of plastics. The candidate displays a very good knowledge of degradable plastic manufacture and knows a very good range of specific uses for degradable plastics. The candidate gives a very good description of how both degradability and tensile strength are measured. Appropriate specialist terms are used throughout. The candidate uses very good spelling, punctuation and grammar and the form and style are of an excellent standard.	[11]–[15]
Level 2 The candidate demonstrates a good understanding of the current issues surrounding the global production and use of plastics. The candidate displays a good knowledge of degradable plastic manufacture and knows a good range of uses for degradable plastics. The candidate gives a good description of how both degradability and tensile strength are measured. Some appropriate specialist terms are used throughout. The candidate uses good spelling, punctuation and grammar and the form and style are of a good standard.	[6]–[10]

<p>Level 1 The candidate demonstrates a limited understanding of the current issues surrounding the global production and use of plastics. The candidate displays a limited knowledge of degradable plastic manufacture and knows a limited range of uses for degradable plastics. The candidate gives a limited description of how both degradability and tensile strength are measured. Little use is made of specialist terms. The candidate uses limited spelling, punctuation and grammar and the form and style are of a basic standard.</p>	<p>[1]–[5]</p>	<p>AVAILABLE MARKS</p>
<p>Response not worthy of credit</p>	<p>[0]</p>	<p>15</p>
<p>Total</p>		<p>75</p>